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First documented cases of cannibalism in *Bothrops moojeni* Hoge, 1966 from the Cerrado of central Brazil

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Cannibalism, defined as the act of consuming an individual of the same species, is a pervasive and ecologically significant behaviour observed across a wide array of taxa (Fox, 1975; Polis, 1981). Among snakes, cannibalism is particularly notable, often occurring as a result of competition for resources, territorial behaviour, or survival strategies in environments where food is scarce (Mitchell, 1986). This phenomenon can serve various ecological and evolutionary functions, including energy advantage (Polis and Myers, 1985), population density (Paterna, 2023), reducing intraspecific competition (Claessen et al., 2000), and providing a crucial nutritional resource during periods of prey scarcity (Morais et al., 2017). For predators like snakes, which usually rely on a generalist and opportunistic feeding strategy, cannibalism may be an adaptive response to the challenges of unpredictable environments (Mayntz and Toft, 2006; Hurd, 2008).

For vipers of the genus *Bothrops*, cannibalism has been documented in several species in both natural and captive settings. For example, cannibalism has been recorded in *Bothrops asper* (Correa-Sánchez et al., 1998), *B. atrox* (Federsoni Jr, 1978), *B. insularis* (Federsoni Jr et al., 1987), and *B. jararaca* (Hermann, 1921). These instances may have been driven by opportunistic predation, or even a strategy to reduce intraspecific competition. In some cases, cannibalism may also reflect limited prey availability, pushing these vipers to exploit all available food sources, including conspecifics. However, cannibalism is an efficient way to obtain energy, as elongated preys provide a higher energy yield in relation to their cross-sectional size, offering a greater mass-to-energy ratio (Maritz et al., 2019).

Bothrops moojeni Hoge, 1966 inhabits the Cerrado ecoregion in central and southeastern Brazil, as well as parts of Argentina, Bolivia, and Paraguay (Buongermini and Waller, 1999; Cacciali et al., 2016). This species has a broad, opportunistic diet that includes small mammals, amphibians, birds, and reptiles (Betzel et al., 2018). Whilst primarily a predator of other species, instances of cannibalism within *B. moojeni* suggest that this behaviour may serve as a survival strategy in response to environmental pressures, paralleling observations in other *Bothrops* species. Here we report the first two cases of cannibalism in *Bothrops moojeni* for a Cerrado area in the state of Mato Grosso do Sul.

On 24 September 2018 and 26 January 2019, we collected two females, ZUFMS-REP04082 (snout-vent length [SVL]: 97.4 cm, total length [TL]: 110.9 cm) (Fig. 1A) and ZUFMS-REP04072 (SVL: 103.9 cm, TL: 118.3 cm), during fieldwork in Parque Estadual das Nascentes do Rio Taquari (-18.274167ºS, -53.704639ºW; elevation 632 m), Alcinópolis municipality, Mato Grosso do Sul, Brazil. Both individuals were fixed in formalin 10% and preserved in ethanol 70% for subsequent analyses and are housed in the zoological collection at the Universidade Federal de Mato Grosso do Sul (ZUFMS-REP). The two specimens were dissected, and their stomach contents were removed for further analysis. In both females, a juvenile conspecific of ~25 cm in total length was found (Fig. 1B). Collection permit SISBIO #45889/1 and IMASUL #71/400151/2018.

Although no genetic analyses were conducted to confirm the relationship between the predators and their prey, we hypothesise that the females and juveniles could have been mother-offspring pairs. Maternal cannibalism, where adult females consume their own young, is well-documented (Lourdais et al., 2005), and has been observed across various snake families, including Boidae

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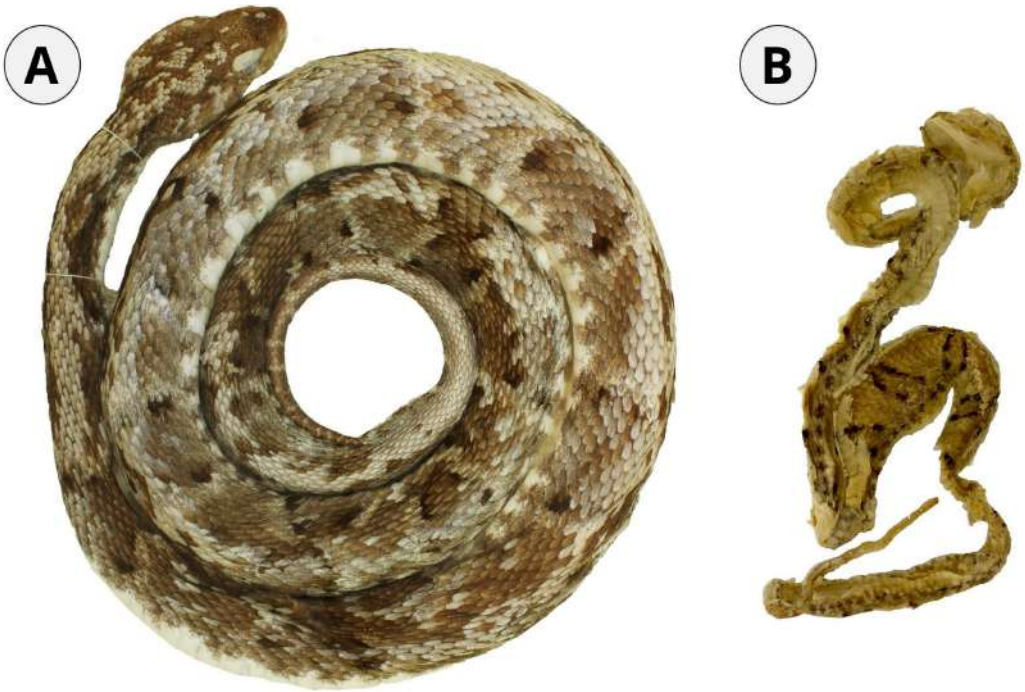

Figure 1. (A) Adult female of *Bothrops moojeni* (ZUFMS-REP04082, snout-vent length: 97.4 cm; total length: 110 cm), and the (B) juvenile found in its stomach contain. Photos by Diego José Santana.

(Hanlon, 1964), Colubridae (Groves and Sachs, 1973), and Viperidae (Williamson, 1971). Some hypotheses have been proposed to explain maternal cannibalism. One suggests it is a protective behaviour, where mothers ingest stillborn or weak offspring to safeguard the health of the surviving young (Lourdais et al., 2005). Another possibility is that cannibalism serves as a strategy for females to quickly recover the energy expended during gestation (Mociño-Deloya et al., 2009), especially in resource-limited environments.

This behaviour may also be viewed through the lens of foraging theory, which posits that larger predators typically avoid smaller prey unless other food sources are scarce or unavailable (Arnold, 1993). In this case, the smaller juveniles may represent an opportunistic food source for the adult females. Even though maternal cannibalism seems to provide a compelling explanation for these events, it's also important to consider that juveniles, being smaller and more vulnerable, could simply be easier prey for larger adults, indeed, *Bothrops moojeni* is known to include small snakes in its diet (Oliveira-Jr et al., 2020).

Additionally, *B. moojeni* exhibits an ontogenetic dietary shift, feeding on ectothermic prey such as amphibians and reptiles in its juvenile stages, and gradually transitioning to endothermic prey, such as mammals, as adults (Nogueira et al., 2003). Adult *B. moojeni* tend to prey more frequently on mammals, including rodents, which form a substantial part of their diet (França et al., 2008). This shift in dietary preference highlights the opportunistic nature of their feeding habits, making it plausible that adult females might consume smaller conspecifics when other prey options are less abundant or in situations of competitive stress.

In conclusion, while maternal cannibalism offers a plausible explanation for the predation of juveniles by females in this instance, it is equally possible that these events were opportunistic in nature, reflecting the broader ecological and dietary adaptability of *Bothrops moojeni*. The ontogenetic diet shift observed in this species further supports the idea that adults may take advantage of any available prey, including smaller conspecifics, under certain conditions. This case highlights the complexity of feeding behaviours in *Bothrops*, emphasising the need for further research, particularly genetic studies, to fully understand the dynamics of cannibalism in these vipers.

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